

Building Strong Communities: Ontario Case Studies For Cleaner Air



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Foreword

The Ontario government is committed to delivering the real, positive change that will make our communities strong, healthy and prosperous. One of these changes is improving the air we breathe. Clean air is essential for healthy, strong, livable communities. Reducing greenhouse gases and energy consumption not only improves Ontario's air quality but it is also good for business.

Municipalities are in a unique position to make a positive contribution towards cleaner air. In fact, many municipalities within the national and international arena have taken on the challenge through concrete action to address air quality and climate change.

The Ontario Ministry of Municipal Affairs and Housing has produced two companion handbooks to assist municipalities:

Building Strong Communities: Municipal Strategies for Cleaner Air makes the connection between urban growth patterns and local air quality. This handbook describes the kinds of creative local policy approaches and tools some municipalities are using in Ontario, Canada and around the world to reduce the negative impact of development on air quality.

Building Strong Communities: Ontario Case Studies for Cleaner Air documents some of the innovative programs Ontario municipalities have put in place to reduce greenhouse gas emissions and airborne pollutants. This handbook identifies several case studies and provides details about the costs, implementation, results, and potential transferability of these municipal initiatives.

These handbooks are intended to inform and inspire municipal government officials, policy makers and other individuals on how they might take action. Together, we can meet the challenges of air quality and climate change and help create a cleaner Ontario. Together, we can strengthen the communities in which we live, providing the people of Ontario with a quality of life that is second to none.

For Your Information

The *Building Strong Communities: Ontario Case Studies for Cleaner Air* handbook details case studies and best practices from municipalities across Ontario, to help inform municipal government officials, policy makers and other individuals on how they might take action.

The case studies and practices summarize complex matters and reflect legislation, practices and projects that differ or are subject to change. These approaches were developed locally and include specific staff, professional and legal advice. Municipalities are responsible for making local decisions, including compliance with any applicable statutes or regulations. For these reasons, the information in this handbook should not be relied upon as a substitute for specialized legal or professional advice in connection with any particular matter. We recommend that municipalities obtain independent legal or professional advice when they evaluate or develop their own proposals.

The user is solely responsible for any use or application of the handbook. The ministry does not endorse any particular method or program, or accept any legal responsibility for the contents of the handbook or for any consequences, including direct or indirect liability, arising from its use.

**Reducing emissions
benefits everyone.
It can create
healthier, stronger
communities.**

The handbook is organized
into four parts:

- i. Background**
answers common
questions about
greenhouse gases
and air quality.
Page 2
- ii. Municipal
Action
Strategies**
describes municipal
strategies available to
reduce GHG
emissions.
Page 4
- iii. Putting Ideas
into Action**
offers practical,
transferable case
studies from Ontario
municipalities.
Page 14
- iv. Opportunities
for Action**
provides information
on networking and
partnership
opportunities, as well
as potential sources of
funding for climate
change initiatives.
Page 54

Introduction

In Ontario and around the world, the actions of individuals and governments are changing our climate and the air we breathe. This handbook highlights what several Ontario municipalities are doing for clean air in their communities. Whether you're a municipal employee, councillor, or concerned resident, this handbook provides practical examples of how municipalities are making a difference and how these initiatives can be tailored to your community, large or small.

Climate change and poor air quality affect the livability of communities, presenting a growing risk to the long-term health and economy of communities. Strong communities need clean air. That means reducing greenhouse gases (GHGs) and other air pollutants. Municipalities have a major role to play in reducing GHGs and airborne pollutants. Municipal operations, policy directions and practices influence more than half of Canada's emissions. Reducing emissions benefits everyone. It can create healthier, stronger communities.

The handbook describes, in some detail, the innovative actions and programs that Ontario municipalities are taking to reduce GHG emissions and air pollutants. The case studies provide detailed information about municipal initiatives including costs, implementation details, results, transferability and where to get more information. The handbook is designed to facilitate information-sharing and offer workable ideas to municipalities, even if your municipality doesn't have dedicated resources available.

Part 1 - Background -

The choices municipalities make matter. Directly or indirectly, municipal actions are linked to approximately half of the GHG emissions in Canada. Municipal actions/operations directly release six to 15 per cent of emissions from municipal buildings, operations, and services such as waste and water management facilities. Indirectly, municipal actions and related activities account for 35 to 50 per cent of emissions – generally through their regulatory operations and other policies and programs (Federation of Canadian Municipalities, 2001).

What is climate change?

Human activity is being blamed for causing a wide range of changes in global temperatures and weather patterns. Experts predict that these changes will increase over the next century, posing challenges for all communities (Ministry of the Environment, 2001). Ontario municipalities could experience:

- increased occurrences of severe weather (e.g., ice storms, heat waves and droughts)
- reduced water levels in the Great Lakes
- increased incidences of mortality and illness due to heat stress and poor air quality
- increased energy costs for cooling buildings
- threats to the health of local plant and animal species

What causes climate change?

Scientists agree that the accumulation of GHGs in the earth's atmosphere contributes to climate change. A certain level of GHGs is needed to maintain the earth's temperature at a level that can support life. However, as the concentration of GHGs in the atmosphere increases, more heat is trapped, causing average global temperatures to rise and weather patterns to change (Intergovernmental Panel on Climate Change (IPCC), 2001).

Directly or indirectly, municipal actions are linked to approximately half of the GHG emissions in Canada (Federation of Canadian Municipalities, 2001).

Nitrogen oxides are building blocks for smog and acid rain, but they also indirectly contribute to the greenhouse effect by initiating ground level ozone formation (IPCC, 2001; Ministry of the Environment, 2001).

- Carbon dioxide (CO₂) is the main contributor to climate change. It is primarily released through the burning of fossil fuels that power vehicles and generate electricity.
- Methane (CH₄) is produced when vegetation and waste are burned or decomposed without the presence of oxygen. Landfill sites and livestock operations are the main sources of methane.
- Nitrous oxide (N₂O) is largely produced when chemical fertilizers and manure are used in agricultural operations.

How is poor air quality related to greenhouse gas emissions?

Poor air quality is an increasing concern for many Ontario municipalities. **Smog, acid rain, hazardous air pollutants and fine particulate matter** are the main contributors to poor air quality. Air quality is a local, regional and even sub-continental problem, because pollutants can travel hundreds or even thousands of kilometres. For example, air pollution frequently crosses between the eastern United States and Ontario (Ministry of the Environment, 2001).

Poor air quality, much like climate change, arises from the combustion of fossil fuels used to power cars and drive industry. As a result, the emission sources that are associated with climate change are often the same ones responsible for poor air quality. Therefore, programs that reduce GHG emissions are helping to address the problem of poor air quality. Nitrogen oxides are building blocks for smog and acid rain, but they also indirectly contribute to the greenhouse effect by initiating ground level ozone formation (IPCC, 2001; Ministry of the Environment, 2001).

Part II

- Municipal Action Strategies -

Ontario municipalities are taking action in many different ways. Some municipalities are involved in national and provincial programs to address climate change and air quality. Thirty Ontario municipalities are members of the Partners for Climate Protection program in association with the Federation of Canadian Municipalities.

In addition, many municipalities have independently developed action strategies to address climate change and reduce GHG emissions. These action strategies can be grouped into seven program areas:

- 1) smog alert programs
- 2) reducing emissions from municipal facilities and operations
- 3) encouraging compact urban form
- 4) supporting transit
- 5) greening communities
- 6) managing waste and water services
- 7) community awareness, education and participation

And they span three types of municipal activity:

- **Operations** – the delivery of municipal services or maintenance of facilities, such as retrofitting municipal buildings or expanding waste diversion efforts
- **Policy and Regulations** – compact urban form planning policies, strategic energy plans or anti-idling bylaws
- **Education** – awareness, education and participation to help communities understand, accept and foster change to lessen climate change and improve air quality.



*Cornell houses in Markham
(See Case Study 6)*

Smog alert programs are relatively easy and inexpensive to develop.



A common response to smog alert programs includes postponing the refuelling of vehicles. (City of Brampton, See Case Study 4)

See Case Study 1, the City of Mississauga's Smog Response Plan, in Part III: Putting Ideas into Action.

1) Smog Alert Programs

Many municipalities, including Essex, Halton, Hamilton, Lambton, Markham, Mississauga, Toronto, Windsor and Sarnia have adopted, or are in the process of adopting smog alert programs, including smog response action plans.

Smog alert programs are relatively easy and inexpensive to develop. The programs identify actions to alert the community of high smog days, as well as responses to reduce emissions associated with activities of individuals, businesses and municipal departments.

Courses of action to reduce smog include:

- reducing air conditioning use in buildings by raising the pre-set temperatures by three degrees Celsius
- reducing non-essential equipment use
- rescheduling lawn mowing, pesticide/herbicide use and leaf blowing
- restricting vehicle engine idling
- restricting the use of gasoline-powered equipment
- avoiding the use of volatile organic compound products such as paints, solvents or cleaners
- postponing refuelling of vehicles
- restricting open burning of garbage

Did you know?

For more information about developing a smog response action plan and to obtain copies of action plans, visit the Ministry of Environment's website at www.ene.gov.on.ca/envision/air/smog/asap2002.htm.

2) Reducing Emissions from Municipal Facilities and Operations

Municipalities have direct control over many emissions associated with their operations, such as the cooling and heating of buildings, vehicles, treatment plants and street lighting.

Alternative Energy Sources

Using alternative sources such as non-fossil, fuel-based energy can substantially reduce GHG emissions from municipal operations. Alternative energy sources are typically clean, natural sources of energy that provide heat and electricity without damaging the environment and depleting resources over time. For example, biomass energy (from renewable organic materials such as forest and agricultural crops and residues, wood and food processing wastes and municipal solid waste) can be used for energy. Other alternative energy sources are solar, small-scale hydro and wind sources (Ministry of the Environment, 2001).

Increasing Energy Efficiency

Municipal operations account for much of the total energy use in a community. Opportunities to increase energy efficiency in buildings may be realized during the following stages:

- design and construction of new facilities
- operations and maintenance of buildings
- building renovations and retrofits

Using alternative sources such as non-fossil, fuel-based energy can substantially reduce GHG emissions from municipal operations.

Case Studies 2, 3 and 4 in Part III, describe how Greater Sudbury, Ottawa and Brampton use alternative energy sources.

The City of Windsor used Energy Performance Contracting to realize energy efficiencies – see Part III, Case Study 5.

Over the last decade, many municipalities have been reconsidering the suburban form of residential development.



Compact urban form involves a higher density form of development that is considered more energy efficient. (King West, City of Toronto)

Case Study 6 describes how the Town of Markham is encouraging compact urban form.

3) Encouraging Compact Urban Form

Suburban developments are often large, low-density, single-use areas. They are a challenge to municipalities in terms of providing cost-effective transit services. The result is that many suburban residents rely heavily on automobiles for mobility, with the side effect of increasing GHG emissions.

Over the last decade, many municipalities have been reconsidering the suburban form of residential development. New communities are being planned based on the concept of compact urban form which is a higher density form of development with a mix of uses and planned linkages between transportation modes such as transit, cycling and pedestrian walkways. This form of development is considered more energy efficient. Transit services can be provided more readily and reliance on the automobile decreases.

Municipalities have a range of land-use planning powers and tools to encourage compact, energy-efficient urban form. These include:

- official plans
- zoning bylaws
- subdivision control
- site plans

The companion to this handbook, *Building Strong Communities: Municipal Strategies for Cleaner Air*, discusses the need to change existing patterns of growth and the effect that land-use planning decisions can have on creating compact urban form. Examples of successful compact urban form projects from across the globe are also highlighted.

4) Supporting Transit

Transit requires much less energy per person, per kilometre travelled, than conventional automobile travel. This results in fewer GHG and smog-forming emissions (IPCC, 2001).

As discussed in the companion handbook, *Building Strong Communities: Municipal Strategies for Cleaner Air*, increasing transit use can reduce vehicle emissions and combat gridlock. The challenges to increasing transit are discussed, such as the need to have appropriate densities and a variety of land uses to support transit. Addressing these challenges will require cross-sectoral and inter-municipal approaches. Nevertheless, there are many simple, low-cost strategies that municipalities can employ to make transit ridership more efficient and attractive and reduce automobile dependency. Traffic experts should be consulted before deciding to take these steps to ensure feasibility.

- **High-occupancy vehicle (HOV) lanes:** In HOV lanes, transit vehicles have exclusive or nearly exclusive use. This reduces transit travel time and increases transit passenger comfort. HOV lanes are created by marking "diamond" lanes using special signs and painting or by widening roads to create new lanes.
- **Queue-jump lanes for transit vehicles:** Queue-jump lanes are shorter but effective versions of HOV lanes, typically extending for less than one block. They are designed to provide additional lanes for buses to bypass queues at intersections.
- **Stopping, turning and parking restrictions:** Stopped, parked, or right-turning vehicles often interfere with transit operation. Municipalities can enact bylaws to restrict such actions, especially during peak traffic hours.
- **Transit malls:** Transit malls are designated areas (sections of a street or series of streets) where transit vehicles are the exclusive, or at least the dominant form of transportation.

There are many simple, low-cost strategies that municipalities can employ to make transit ridership more efficient and attractive and reduce automobile dependency.



HOV lanes are created by marking "Diamond" lanes using special signs and painting.

The City of London Transit Commission has a fare restructuring strategy. See Case Study 7.

For more about these alternatives, see *Transit-Supportive Land Use Planning Guidelines*, a joint publication of the Ministry of Municipal Affairs and the Ministry of Transportation, available at http://www.mah.gov.on.ca/userfiles/HTML/nts_1_3173_1.html.

- **Parking spaces and parking fees:** When parking is available, transit is less attractive to many travellers. In areas that are well served by transit, municipalities could increase parking fees in municipal lots, or eliminate free parking. Conversely, making enough parking spaces available at transit junctions encourages people to park and ride public transportation.
- **Innovative transit fares:** Cost greatly affects how people choose to travel. Discounts to target groups, such as monthly commuter passes, can increase transit ridership. Municipalities can also offer transit incentives for employees and/or students, such as issuing free or reduced-fee transit passes.
- **Transfers between transit modes and systems:** To attract ridership, transfers should be convenient and inexpensive. Integrating fares and co-ordinating service can create seamless transfers and improve transit rider convenience and use.

5) Greening Communities

A community can be 'greened' through a program of urban forestry, planting trees and shrubs, or through vertical gardens and incorporating vegetation into building envelopes. It can be done by creating greenbelts along the edges of urban areas, preserving and greening rural fencerows, city parks, streets, and roof tops.

The benefits to greening, aside from increasing the attractiveness of the community, include an improvement to air quality, reduction of emissions and cooling of air temperature. 'Greening' helps to provide shade from the sun and shelter from winter winds, removes carbon dioxide from the atmosphere, and traps dust particles on leaf surfaces. Most importantly, greening reduces the urban "heat island" effect of increased temperatures and poor air quality. The "heat island" effect is the result of large areas that are predominately covered with asphalt, buildings and other modern developments (Local Enhancement & Appreciation of Forests – <http://leaf.toronto.org>).

Green roofs are particularly beneficial. They reduce the energy required to heat and cool buildings by acting as insulation as well as absorbing urban noise and providing a tranquil refuge for people (Green Roofs for Healthy Cities – <http://www.greenroofs.ca/grhcc/main.htm>).

Municipalities can develop Green Plans or Urban Forest Strategic Plans to guide the preservation and improvement of green areas. The City of St. Catharines, for example, has an action plan for protecting and enhancing its green spaces.

Green roofs reduce the energy required to heat and cool buildings by acting as insulation.

Working with partners, the City of Toronto developed a Green Roof Infrastructure Demonstration Project in 2000. See Case Study 8 for details.

6) Waste and Water Management

Waste Management

The Region of Waterloo operates a landfill gas utilization program. See Case Study 10.



Waste diversion through recycling and composting help to reduce GHG emissions

Municipal solid wastes produce GHG emissions in two ways. First, emissions come from the energy required to operate the buildings, equipment and vehicles used in waste collection and disposal. Second, landfill sites produce methane, a potent GHG (Federation of Canadian Municipalities, 2001).

Two common techniques to reduce emissions associated with municipal waste management are:

- **Waste diversion:** Solid waste is diverted from landfill sites, through either reduction or alternative management options, such as recycling and composting. See Case Study 9 for information about Centre and South Hastings' successful recycling program.
- **Capturing and using landfill gas:** Landfill gas emissions account for 26 per cent of Canadian methane emissions. Landfill gas also creates nuisance odours, health risks from toxic and carcinogenic trace substances, safety risks due to potential explosions from built-up gases, smog from the volatile organic compounds in the gas and stress on vegetation.

Water and Wastewater Management

Canada has the second highest per capita water consumption rate in the world. Purifying, distributing and heating water requires a lot of energy, which in turn produces GHG emissions. Reducing water consumption can reduce emissions, as well as costs for water and services (Environment Canada, 1998).

Practising water conservation for household uses can significantly reduce consumption.

Many governments have established water conservation programs that restrict residential activities such as lawn watering and have conducted outreach through public education and communications (Environment Canada, 1998).

Other effective water conservation techniques include rainwater collection programs, graded pricing mechanisms and water meters on buildings.

Canada has the second highest per capita water consumption rate in the world.

Treating wastewater also requires a lot of energy. Municipalities can reduce GHG emissions associated with wastewater treatment by adopting alternative treatment techniques or capturing biogas produced in treatment and reusing it for further energy production. Alternative treatments include the use of aquatic plants, marshes or wetlands to treat wastewater (Public Works and Government Services Canada, 2002).

The City of Ottawa has started an extensive wastewater biogas recovery and cogeneration program. See its website at http://ottawa.ca/city_services/waterwaste/env_pro_en.shtml.

The City of Barrie developed a new water rate structure. See Case Study 11.



The use of aquatic plants, marshes or wetlands helps to treat wastewater.

The Town of Brighton operates a treatment wetland. See Case Study 12.

The City of Ottawa has started an extensive wastewater biogas recovery and cogeneration program. See its website at http://ottawa.ca/city_services/waterwaste/env_pro_en.shtml.

7) Community Awareness, Education and Participation

Municipalities indicated that community awareness programs and education directed at municipal employees and local residents are critical to building an understanding of climate change and support for municipal actions to reduce GHG emissions. In general, programs that involve and encourage active participation by citizens have proven very successful.

Regular updates and reporting on performance measures and achievements are key to building public commitment.

Municipalities have developed a range of internal activities such as employee information luncheons, staff newsletters and bulletins in employee pay receipts. In the community, awareness about local initiatives can be raised through media releases, local television public announcements, articles in local papers, and signs posted at sites where emission-reducing measures have been taken. Regular updates and reporting on performance measures and achievements are key to building public commitment. They also encourage residents to take action.

The City of Hamilton launched a community awareness campaign on air quality. See Case Study 13.

Did you know?

The website 'Tools of Change: Proven Methods for Promoting Health and Environmental Citizenship' www.toolsofchange.com offers information on proven methods to motivate people to take action in their communities.

The City of Burlington uses traffic calming plans to educate residents about vehicle emissions released at all-ways stop signs. See Case Study 14.

Part III

Case Study 1: Smog Response Plan - City of Mississauga -

Goals

- to increase staff and public awareness and understanding of the effects of smog
- to identify actions to decrease emissions on smog alert days
- to inform stakeholders about the City's activities during a smog alert

Actions

The City established the Mississauga Air Quality Advisory (MAQA) Committee in February 1998 to recommend actions to reduce emissions associated with local air pollution and climate change.

The Smog Response Plan began as a pilot in 1998. Modest operational modifications were required to implement the plan, which is revised annually. The plan includes:

- notification procedures to employees and ratepayers
- corporate operational responses
- a communication strategy
- management actions to enhance smog alert responses and reduce emissions over the longer term

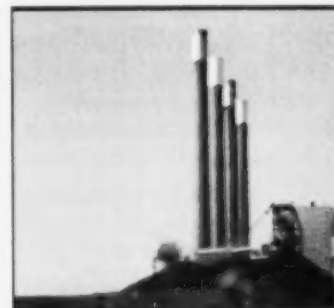
Operational responses on smog alert days include:

- reducing use of non-essential equipment
- replacing gas and diesel-powered tools and equipment with hand tools in parks after 10:00 a.m.
- curtailing the use of oil-based paints and solvents
- rescheduling street sweeping to nights
- reducing municipal vehicle engine idling

Implementation Details

The city uses the Ministry of the Environment's email notification system to alert staff and the public of smog alert days. Municipalities can subscribe to an employee e-mail notification service at no cost through MOE's Air Quality Ontario website (<http://www.airqualityontario.com/alerts/signup.cfm>).

The communication strategy includes messages to be relayed both prior to and during a smog alert. Communication is designed to reach municipal staff and public audiences.



Cities can establish committees that recommend actions to reduce emissions associated with local air pollution and climate change.

The city uses the Ministry of the Environment's email notification system to alert staff and the public of smog alert days.

Results

On smog alert days, city employees and ratepayers are notified early and the plan's operational responses are implemented.

Transferability

A smog response plan can be adopted in any municipality. Upfront costs are low and information on smog alerts is readily available from the Ministry of the Environment by fax or email. Sufficient staff time and inter-departmental co-operation, as well as support from senior management and council, are important to a plan's success.

Management

The Smog Response Plan is reviewed yearly by the MAQA Committee.

Costs

Each department absorbs the costs of implementing the plan.

Did you know?

In June 2000, the city received Honourable Mention under the Federation of Canadian Municipalities-CH2M Hill Sustainable Community Award. Placing in the top five of 52 competing communities in Canada, Mississauga was recognized for the implementation of its Air Quality Action Plans, including its Smog Response Plan.

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Case Study 2: Solar Ventilation Air Heating - City of Greater Sudbury -

Goals

- to reduce electricity-based space heating requirements in sewage treatment plants
- to improve air circulation at sewage and water treatment plants

Actions

The City of Greater Sudbury installed two passive solar walls in two facilities – the Wanapitei and Sudbury sewage treatment plants – as part of its Strategic Energy Plan.

Contracts were signed in late 1999 and the installation of the solar collection and distribution equipment was completed in spring 2000.

Implementation Details

The implementation of solar walls in the two treatment plants encountered few barriers during the recommendation and review process.

The project involved mounting solar collectors (perforated plates) on the southern facades of the buildings and installing a fan to provide solar heating air to the buildings' distribution system. A summer bypass system triggered by high outdoor temperatures reduces heat in the buildings.

Results

The solar walls at the Sudbury plant generate annual savings of approximately \$10,500 in electrical energy costs. This is equivalent to 27 tonnes of CO₂ emissions. The solar wall installation for the Wanapitei plant is producing similar results.

Transferability

Solar walls have been used in the province for many years with good results.

While the technology has widespread applicability to existing facilities, installing these systems is most cost efficient during new construction or the renovation of existing walls. Installations require correct building positioning and a minimum wall area to be economically viable.

Solar ventilation air heating systems are best supported through comprehensive retrofit programs such as Greater Sudbury's

The solar walls at the Sudbury plant generate annual savings of approximately \$10,500 in electrical energy costs.



Solar walls have been used in the province for many years with good results.

Strategic Energy Plan. This shows the public and decision-makers the link between individual projects and broader municipal energy efficiency objectives.

Management

Building energy use data is gathered through on-site data collection equipment. Monthly building performance reports are issued based on this data, which is compared to the projected performance of the solar walls.

Costs

Installation of the solar walls costs approximately \$30,000 each, including design and engineering costs. Approximately 5 per cent of total costs went towards feasibility studies.

Did you know?

The city is a member and active partner of the International Council for Local Environmental Initiatives' *Cities for Climate Protection in Canada*. For more information on this program, visit <http://www.city.greatersudbury.on.ca/>.

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Case Study 3: Street Lighting Conversion Program - City of Ottawa -

Goals

- to reduce the city's energy costs for municipal street lighting
- to reduce the city's street-lighting-related CO₂ emissions by 20 per cent by the year 2005

Actions

The city initiated a program to replace inefficient incandescent and mercury vapour street lights with a high-pressure sodium lighting system.

Implementation Details

The program had high upfront costs but was relatively easy to implement. The city obtained grants from the former Ontario Hydro. The retrofit took four years to complete.

Results

Energy use from street lights immediately dropped by 30 per cent, even with 1,000 additional street lights added to the network.

CO₂ emissions from street lighting were reduced by 2,368 tonnes per year from 1990 to 1996, representing 36.1 per cent of Ottawa's overall target to reduce CO₂ emissions.

Transferability

Implementation may be difficult if municipalities do not have designated funds to meet high upfront costs, although this can be overcome through grants, loans, or alternative financing/debt management strategies.

Management

The City's Environmental Management Branch monitors the program and prepares annual progress reports to council on the GHG reductions.

Costs

The program cost approximately \$4 million, with 25 per cent of the capital cost covered by the former Ontario Hydro grant.

Street lighting energy cost was reduced from an estimated \$1.52 million to \$1 million per year.

Maintenance costs were reduced by \$350,000 per year, even though

Energy use from street lights immediately dropped by 30 per cent, even with 1,000 additional street lights added to the network.

Street lighting energy cost was reduced from an estimated \$1.52 million to \$1 million per year.

5,000 fixtures have been added in the last five years.

The payback period of the initiative was just over four-and-a-half years.

The City of Ottawa co-ordinates a series of CO₂ emission reduction programs under its Corporate Plan Program for GHG reduction. These include retrofitting city facilities, the S.M.A.R.T. employee transportation program (an employee commuter program), city employee awareness programs and a fleet energy reduction strategy.

Did you know?

Natural Resources Canada and the International Council for Local Environmental Initiatives estimate that 25 jobs are created for every million dollars spent on energy efficiency retrofits.

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Case Study 4: Fleet Conversion to Biodiesel - City of Brampton -

Goal

- to demonstrate municipal leadership in the reduction of GHG emissions by diesel-powered vehicles and equipment

Actions

In May 2002, the City of Brampton began a pilot project to convert 16 vehicles from using diesel fuel to B20 biodiesel fuel. Fleet Services of the Works and Transportation Department brought the idea forward, advising that:

- Biodiesel (fatty acid alkyl esters) is a clean-burning diesel replacement fuel made from natural, renewable sources such as soybean and vegetable oils, or animal fats
- Biodiesel is biodegradable, non-toxic and essentially free of sulphur and aromatics
- Using biodiesel in a conventional diesel engine will substantially reduce emissions of unburned hydrocarbons, carbon monoxide, sulphates and particulate matter
- Biodiesel contains no petroleum, but can be blended at any level with petroleum diesel to create a biodiesel blend (e.g., 20 per cent biodiesel and 80 per cent diesel, or B20)

The pilot was a success. The Works and Transportation Department subsequently went to a 50/50 blend of biodiesel-petroleum diesel (B50) for 200 city vehicles.

Implementation Details

Biodiesel for larger vehicles is delivered by tanker. For smaller vehicles and equipment, storage facilities were set up at four city-owned locations. Two pick-up trucks with mini tanks in the rear are used to fuel off-road equipment such as park mowers.

Reactivation of underground fuel tanks at one city yard to store and dispense biodiesel is under review. The remote stations would still be used to supply smaller equipment, not based at this yard, with the mobile mini tanks still fuelling off-road vehicles.



Biodiesel is biodegradable, non-toxic and essentially free of sulphur and aromatics.

Using biodiesel in a conventional diesel engine will substantially reduce emissions of unburned hydrocarbons, carbon monoxide, sulphates and particulate matter.

Any municipality that has a diesel fleet and access to a convenient supply of biodiesel fuel could convert its municipal fleet to biodiesel. A number of Canadian companies offer biodiesel as a fuelling option.



Any municipality that has a diesel fleet and access to a convenient supply of biodiesel could convert its municipal fleet to biodiesel.

Result

During the pilot, diesel-related GHG emissions were lowered by 24 per cent using the B20 blend. As of June 2003, city council had committed to the permanent use of B20 biodiesel fuel for its fleet of 130 transit buses.

Transferability

Biodiesel significantly reduces GHG emissions from municipal operations, making it a ready alternative for municipal fleets, especially in communities with poor air quality.

Any municipality that has a diesel fleet and access to a convenient supply of biodiesel fuel could convert its municipal fleet to biodiesel. A number of Canadian companies offer biodiesel as a fuelling option.

In addition to exploring the advantages of biodiesel, municipalities may want to consider the benefits of other alternative fuels, such as ethanol and natural gas.

Management

Fleet staff test emissions regularly.

Costs

The cost of petroleum diesel in 2002 was approximately 69 cents per litre. Biodiesel costs slightly more, because it is more expensive to produce. However, the Ontario government has exempted biodiesel from the 14.3 cents-per-litre Ontario fuel tax, making biodiesel competitively priced.

No additional capital costs were incurred with the switch to biodiesel, as it works interchangeably with traditional diesel in combustion-ignition engines.

A computerized municipal fuelling system may also be considered. While not essential, it can control fuelling activities and collect data to evaluate the efficiency and effectiveness of fuel use. The approximate cost is \$45,000, including testing of existing tanks and the purchase and installation of the unit.

Did you know?

Brampton was the first Canadian municipality to commit to the ongoing use of biodiesel for its diesel-fueled vehicles and off-road fleets.

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Case Study 5: Energy Performance Contracting - City of Windsor -

Goals

- to upgrade city facility operations
- to permanently reduce electrical operating costs at city facilities
- to improve indoor air quality in city buildings
- to develop or improve city building system documentation

Actions

The City of Windsor wanted to reduce its energy costs and improve its energy efficiency. The city had goals, but lacked the capital to make the improvements. The city decided to enter into a contract with an energy service company.

ESCOs specialize in implementing energy management projects to achieve measurable economic results, while addressing environmental goals.

Energy Services Companies, or ESCOs, are companies that enter into agreements with municipalities to provide services relating to their energy needs. Such companies are often paid based on their performance under an Energy Performance Contract; for example, according to the amount of energy saved from the retrofitting. ESCOs specialize in implementing energy management projects to achieve measurable economic results, while addressing environmental goals. Depending on a municipality's objectives or the specific service provided, ESCOs can provide technical expertise and guarantee energy savings.

Through an energy management study, the ESCO identified what retrofits could be made to the Windsor facilities and what savings could be realized. As a result, Windsor achieved significant annual energy savings and greater efficiency without paying any capital costs.

Implementation Details

The energy efficiency improvements were implemented in three phases:

- The first phase involved 19 facilities of the Department of Parks and Recreation
- The second phase covered numerous city-wide facilities, including City Hall, the Fire Department and the Transit Centre
- The third phase was undertaken on the main municipal library

Types of energy efficiency improvements and retrofits included:

- upgrading lighting in the facilities
- upgrading air handling systems
- replacing boilers

Results

The city completed three ESCO contracts, upgrading energy efficiency in many of its facilities without substantially depleting its capital reserves.

Energy savings predicted with the retrofits were 5.7 million kilowatts per year. To date, all three phases have outperformed their projections.

Energy efficiency measures have enabled the city to deliver low-cost, high-quality services by maintaining efficient operations without raising property taxes.

Transferability

Any municipality that lacks sufficient financing or internal technical knowledge, or has tight deadlines, may benefit from performance contracting.

Contracting with an ESCO is an alternative to retaining multiple consultants. ESCOs can also be contracted to provide specific tasks to municipalities undertaking energy retrofits. By hiring an ESCO, a municipality can avoid "multiple-decision-maker syndrome," which can slow project progress.

There are a number of ESCOs in the Ontario marketplace.

Did you know?

Legal and risk assessment considerations should be undertaken before entering into any long range financing projects.

Management

Windsor implemented its energy retrofits through alternative financing methods that included entering an energy performance contract with the ESCO, MCW Energy Reduction Services Ltd. This method limited the initial capital expense for the improvements and shortened implementation time.

To date, all three phases have outperformed their projections.

By hiring an ESCO, a municipality can avoid "multiple-decision-maker syndrome," which can slow project progress.

Costs

Energy retrofits cost \$3.6 million for Phases 1 and 2. Energy savings are estimated at \$560,000 per year.

The estimated payback period for the retrofits is 7 to 10 years. (Payback time varies based on the type of retrofit. For lighting retrofits, the payback period is 2 to 3 years. For other retrofits, payback may take as long as 10 years.)

Did you know?

The City of Windsor has developed a community energy system which has allowed the Windsor Utilities Commission to close some small power plants, increase energy efficiency and reduce GHG emissions and other air pollutants.

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Case Study 6: Compact Urban Form - Town of Markham -

Goals

- to accommodate growth within a compact urban form
- to achieve higher transit usage
- to balance urban growth with the protection and enhancement of the natural environment

Actions

The Town of Markham developed planning policies that encourage compact urban form. Two substantial plans are for the Cornell Community and Markham Centre.

Both the Cornell Community and Markham Centre follow the principles of "New Urbanism" and "Smart Growth." The town developed policies for these new communities that include supporting higher density built form, pedestrian-friendly streetscapes and a mix of land uses.

This case study focuses on the plan for Markham Centre.

Markham Centre is planned as the town's downtown core. The town has provided direction to the development industry by creating policies that will enable:

- 10,000 units of mixed density housing
- 17,000 jobs in new office employment
- 30 hectares of parkland
- pedestrian-friendly streetscapes and nature paths
- limited expansion of the urban boundary
- a rapid-transit system

Implementation Details

The vision of Markham Centre evolved through a series of public meetings and workshops held in the early 1990s.

In 1992, the town commissioned a study to facilitate a Master Plan for Markham Centre. The intent was to provide for a wide variety of uses, including residential, employment, commercial, recreational, cultural and institutional activities in a compact urban form.

The planning process involved a number of consultation charettes where Markham residents, businesses, consultants, politicians and town staff developed the vision for Markham Centre.

The vision of Markham Centre evolved through a series of public meetings and workshops held in the early 1990s.



New urbanist communities support higher density built forms, pedestrian-friendly streetscapes and a mix of land uses.

In 1993, Council approved changes to the designated urban boundaries of Markham. The *Markham Centre Secondary Plan* was adopted by Council in 1994 and approved by the Ontario Municipal Board in 1997.

A citizen advisory group was established in May 2002 to assist the Town in its review of development proposals and provide feedback. Performance measures were developed for:

- greenlands
- green infrastructure
- transportation
- built form
- open spaces



Compact urban development reduces reliance on cars and supports growth that has minimal impact on the environment.

The first development applications were reviewed, in consultation with the advisory committee, having regard for the performance measures.

Results

There is clear town direction to the public and development sectors to build a downtown centre that uses land and infrastructure efficiently, reduces reliance on cars and supports more sustainable forms of growth with minimal impact on the environment.

Development principles and performance measures are incorporated into the *Markham Centre Secondary Plan* and provide a basis upon which to review new development applications.

Transferability

As municipalities strive to build strong, cleaner air communities, measuring progress against stated goals is essential. The performance measures and public consultation processes employed in *Markham Centre* are a model that other municipalities can adopt.

Management

The *Markham Centre* team works with an advisory committee, steering committee, council, residents and other stakeholders to implement their plans.

Costs

Markham Centre has developed over a long period of time, beginning with a series of public meetings and workshops in the early 1990s, to the approval of the *Secondary Plan*, including staff committees and resident participation. For this reason, it is difficult to provide an overview of the costs.

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Case Study 7: Fare Restructuring Strategy - City of London -

Goals

The London Transit Commission's fare-restructuring strategy has the following goals:

- to increase revenue
- to maintain and build ridership
- to ensure that the fare administration system is efficient and effective



The City of London has many innovative transit fare arrangements that make ridership more appealing.

Actions

Starting in 1996, the London Transit Commission developed a transit fare restructuring strategy introducing several innovative transit fare arrangements aimed at increasing ridership and decreasing automobile use. The design of pricing and fare options reflected the following principles:

- Passengers are sensitive to savings
- Pricing and media options can influence choice and service use
- Passengers will pay for quality in terms of service design, frequency and customer service

The commission produced new fare packaging and pricing options:

- 'Deep discount' tickets allow riders to buy tickets in strips at a substantially lower price than the cash fare. (In 2003, tickets purchased in units of five cost \$1.65 each, versus a cash fare of \$2.25).
- A '90 minute transfer' provides an hour-and-a-half window for travel from the first time of boarding. Riders can make stopovers and travel in any direction, including return trips.
- Tuition-based pass programs are available to full-time post-secondary students. There are three programs covering the University of Western Ontario's undergraduates and graduate students and Fanshawe College students.

Implementation Details

The London Transit Commission worked collaboratively with the student councils of the University of Western Ontario, Western's Society of Graduate Students and Fanshawe College. All full-time

students pay the transit pass fare as part of their tuition fees. Fares are based upon either a 12-month (September to August, approximately \$120) or an eight-month (September to April, approximately \$100) pass.

Development and implementation of the program included:

- identifying the respective student councils as champions of the program and obtaining their approval
- conducting market research among students
- each student council undertaking a referendum, from which there was overwhelming support for the program
- obtaining the approval of the London Transit Commission
- entering into contracts with the respective student councils setting out roles, responsibilities and pricing, including a mechanism for future price increases

Annual ridership increased from 11.9 million to 16.1 million.

Results

The overall goals associated with fare restructuring were met. Specific targets regarding service levels and usage have been exceeded.

The fare restructuring initiative in general and the tuition-based pass program contributed to the following changes between 1996 and 2002:

- Annual ridership increased from 11.9 million to 16.1 million
- Revenue service hours increased from 472,000 to 487,000 hours annually. (This is the amount of revenue generated from the fare box based on the amount of hours transit service is offered. Transit commissions typically also have other forms of revenue, such as advertising.)
- Ridership per revenue service hour has increased from 25.2 to 33.3 rides per hour
- Revenue recovery (percentage of cost paid by the customer) has remained consistent at approximately 65 per cent
- Post-secondary student ridership increased substantially, with 600 fewer parking permits sold at the University of Western Ontario in the initial year, and the program has supported a reduction in the number of parking permits for students at both the University of Western Ontario and Fanshawe College
- Ridership and community satisfaction have risen substantially.

Ridership per revenue service hour has increased from 25.2 to 33.3 rides per hour.

Transferability

Other transit systems considering a tuition-based pass program should be prepared to invest considerable time upfront in developing the concept in consultation with student councils. This could go beyond the term of a current council.

The same framework can serve as the basis for developing employer-sponsored pass programs.

Management

The tuition-based pass program is governed by contracts between the London Transit Commission and the respective student councils of the university and college. Staff of the respective organizations administer the contracts. A mechanism for price increases based on a change in the consumer price index for transportation is included in the contracts.

The management of the program includes establishing a vehicle for communicating issues as they arise, including issues of service, enrolment levels, pass design and reconciliation of fares collected.

Costs

Advertising costs associated with the 1996 fare restructuring initiative were higher than costs associated with traditional fare change campaigns. The tuition-based pass program also involved higher research and development costs. However, the success of the program offsets these costs.

The majority of ongoing administration costs for the tuition-based programs are the responsibility of the respective student councils.

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Case Study 8: Green Roof Infrastructure Demonstration Project - City of Toronto -

Goals

- to determine the public and private performance benefits of green roof infrastructure
- to demonstrate that green roofs reduce urban heat island effects, smog formation, energy consumption and GHG emissions
- to understand the costs and benefits of establishing programs to provide incentives for private green roof installation across the city
- to provide public access to a range of different green roof applications

Actions

With the Green Roofs for Healthy Cities and member companies, the Toronto Atmospheric Fund, the Federal Government and the City of Toronto started a Green Roof Demonstration Project.

Two demonstration green roofs were constructed:

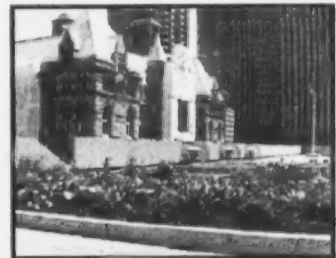
- eight plots covering more than 300 square metres on the podium roof of Toronto's city hall, representing a mix of different landscapes and two different types of green roof infrastructure
- a 465 square metre green roof on the Eastview Neighbourhood Community Centre

Implementation Details

The Green Roof Demonstration Project was launched on November 2, 2000. Council approved both projects.

The city hall green roof required city council to fast track capital works funding by four years to replace existing roofing membranes with root-repellent waterproof membranes. The roof on the Eastview Neighbourhood Community Centre needed replacement. A portion of the new roof was fitted with a green roof. Replacing the membranes was critical to ensuring that the new roof systems were eligible for warranties.

Both roofs took approximately one month to replace, with the plantings following in the spring. The city hall green roof was completed and in bloom in the spring of 2002.



Green roofing increases greenspace in a city environment and helps to remove toxic pollution from the air we breathe.

Creating green roofs on approximately 25 per cent of total available roof space would reduce summer air temperatures in the City of Toronto by one to two degrees Celsius.



Rooftops reduce the energy required to heat and cool buildings by acting as insulation.

Each roof is embedded with sensors that transmit performance data to the National Research Council (NRC) Institute for Research in Construction. The NRC is examining issues such as thermal conductivity, energy efficiency, storm water retention and membrane durability. The Eastview site will also monitor storm water retention and water quality improvements achieved from the green roof vegetation.

Results

Modelling to determine the ability of green roof infrastructure to reduce the urban heat island effect was conducted by Environment Canada in partnership with the University of British Columbia. This research showed that green roofs can save energy, reduce GHG emissions and improve air quality on hot summer days.

Creating green roofs on approximately 25 per cent of total available roof space would reduce summer air temperatures in the City of Toronto by one to two degrees Celsius. It would also lower the incidence of smog formation by 5 to 10 per cent and reduce air pollutants by 30 tonnes and GHG emissions by 2.18 megatonnes.

Transferability

Different climate, density and building layout will result in different benefits from a green roof.

Municipal governments may be able to use fast tracking, energy conservation incentives, own green roof procurement and other measures to encourage the development of green roofs.

It is important to involve a number of departments in a green roof program, particularly works, engineering, planning and urban design.

Management

For the first two years, the City of Toronto and Green Roofs for Healthy Cities managed the roofs jointly. After that period, the city assumed the management of the project.

Costs

The City Hall Green Roof cost \$140,000; the Eastview site cost \$135,000. Other costs were incurred for re-roofing the Eastview and city hall sites, modelling the urban heat island and associated research, project management and public outreach. However, because this was a pilot project, it may not be indicative of the actual costs of developing a green roof.

The cost of an extensive green roof varies widely, but is typically \$1.50 to \$4.50 per square metre. Many municipalities and organizations have examined types of public incentives for green roofs to help offset the high capital costs. Energy efficiency savings are difficult to predict, but cooling benefits can range from 20 to 40 per cent in energy savings.

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Case Study 9: Residential Recycling Program - City of Quinte West -

Goal

- to divert 50 per cent of residential waste

Actions

Quinte Waste Solutions, operated by the Centre and South Hastings Waste Services Board, was established in 1989 to implement 3R activities – reduce, reuse and recycle – in seven municipalities across the area.

The board's approach was to separate at source to maximize diversion volumes and revenues, as well as reduce operational costs.



Recycling diverts solid waste from landfill sites thereby reducing GHGs emissions.

Beginning in 1991, the blue box program expanded to accept polyvinyl chloride, polystyrene, plastic tubs, low-density polyethylene film, polycoat, aluminum foil and trays, textiles and empty aerosol and paint cans.

Implementation Details

Recyclables are picked up weekly and sorted into seven compartments on each truck.

A permanent household hazardous waste depot was established in 1993 and each year a number of member municipalities host collection days for this waste.

Since 1990, 29,000 backyard composters have been distributed.

Results

Almost 23,500 tonnes of residential waste were generated in 1998, equal to 346 kg per person. Of that, 15,005 tonnes, or 64 per cent, were diverted:

- backyard composting and source waste diverted 17 per cent
- recycling diverted 30 per cent
- leaf and yard waste diverted 16 per cent
- household hazardous waste diverted less than 1 per cent

Transferability

Small communities can start an expanded blue box program, especially if they subscribe to an upper-tier or area-wide recycling service.

Management

Quinte Waste Solutions owns the material recovery facility and contracts out collection and processing of all recyclable material. Each municipality involved in the program is responsible for its own garbage collection and disposal.

A key administrative challenge is to balance the operational costs with revenues. Recyclables processing and resale is another management challenge, as packaging practices change frequently.

Costs

The program requires levies from the seven participating municipalities, since revenue from the sale of recyclable materials does not cover the total cost of collecting and processing the recyclables.

In 2001, blue box recycling (collection at \$1,609,850 and processing at \$665,400, not including compost, household hazardous waste, etc.) cost a total of \$2,275,250. Revenue of \$1,183,000 was generated.

More than 100 Ontario municipalities now finance their waste services through user-pay systems.

Did you know?

More than 100 Ontario municipalities now finance their waste services through user-pay systems. These systems tend to produce less waste as users change their buying habits, increase their own composting, or recycle more waste to avoid user charges. (Tools of Change: Proven Methods for Promoting Health and Environmental Citizenship website – <http://www.toolsofchange.com/English/CaseStudies/default.asp?ID=105>)

Full user-pay garbage programs have been implemented in four municipalities by the Centre and South Hastings Waste Services Board, involving about 80 per cent of the people in the area.

User-pay garbage programs have boosted waste diversion rates by Centre and South Hastings Waste Services Board. For example, when the former Sidney Township (now part of the City of Quinte West) introduced their user-pay garbage program (one bag per week at no cost, each additional bag \$1.50), waste to the landfill was reduced by 46 per cent. Recycling tonnages increased by 26 per cent.

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Case Study 10: Landfill Gas Utilization Program - Region of Waterloo -

Goals

- to recover a potential energy resource from methane gas
- to reduce GHG emissions and the associated negative environmental impacts

Actions

The region's Waste Management Division operates landfill sites in both Cambridge and Waterloo. The Waste Management Division entered into an agreement with Toromont Energy Ltd. to use the landfill gas from the Waterloo site to produce electricity.

After a one-year construction period, Toromont opened a 3.7 megawatt power station at the Waterloo landfill in August 1999. The plant began producing power for electricity and heating using landfill methane.

The region signed a 20-year agreement with Courtice Steel to use methane from the Cambridge landfill site to heat the company's steel reheating furnace.

Implementation Details

The contract between the region and Toromont included a commitment by the region to purchase power for the municipality and emission reduction credits for the region. When this contract was negotiated, emission reduction credits which are given when landfill methane is destroyed, were traded through the Pilot Emission Reduction Trading (PERT) project. PERT was a voluntary pilot project aimed at exploring and developing recommendations for further emission trading initiatives in Canada. PERT has since evolved into CleanAir Canada Incorporated which is a source of independent information about GHG emissions trading. The rules around emissions trading are changing; visit the CleanAir website at www.cleanaircanada.org to find out the latest.

Toromont Energy signed a long-term agreement with the Region of Waterloo, owner and operator of the landfill, for the right to use the landfill gas. In return, the region receives royalties from the company.

Results

At full capacity, the Waterloo landfill is expected to produce up to 2,182 cubic metres per minute of methane gas. This generates an



At full capacity, the power plant can generate an estimated eight megawatts of power - enough electricity to serve 4,000 homes.

The Waterloo landfill is expected to produce up to 2,182 cubic metres per minute of methane gas.

estimated eight megawatts of power – enough electricity to serve 4,000 homes.

The Waterloo landfill is expected to reach capacity by 2028, but it will produce sufficient methane to fuel the on-site electricity generating station well into the middle of the 21st century.

Gas from the Cambridge landfill will meet up to 10 per cent of Courtice Steel's fuel needs.

Transferability

Several other municipalities utilize landfill gas. The City of Toronto recovers gas at three landfills to generate 50 megawatts of electricity.

Most active landfills are possible sites for landfill methane utilization projects. Larger sites have greater potential for cost recovery or revenues.

Transferability requires the co-operation of the landfill operator and a power utility company.

Management

Toromont owns and operates the landfill gas power plant in Waterloo. The region operates the gas collection and flaring system and routinely monitors methane and CO₂ levels at the Waterloo and Cambridge sites.

Costs

The power plant project was completed in less than nine months. The capital cost to the Region of Waterloo was an estimated \$7.5 million, plus \$4 million to install the gas collection and flaring system. The construction costs of drilling extra extraction wells at the Cambridge landfill site and the piping to Courtice Steel was paid for by Courtice Steel.

The region estimates that royalties will exceed \$100,000 per year.

Did you know?

The Region of Waterloo's Waste Management Centre was certified under the environmental management standard ISO 14001 in June 1998. It was the first municipal site in Canada to be certified to meet this international standard.



Landfill methane gas is converted to power for electricity at the Toromont power station in Waterloo.

The region estimates that royalties will exceed \$100,000 per year.

In Ontario, pursuant to Ontario Regulation 232/98 under the *Environmental Protection Act*, all new landfill sites that have greater than a 2.5 million tonne capacity must capture methane emissions and either flare the gas off or utilize it in an energy recovery facility. Ontario is one of the first jurisdictions in Canada to enact such a requirement.

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Case Study 11: Water Demand Management - City of Barrie -

The funding structure is self-sustaining, without reliance on tax revenues.



Many municipalities have established water conservation programs that include rainwater collection.

Goals

- to supply high quality, sustainable and affordable water services to city residents
- to encourage water conservation
- to reduce wastewater flows
- to meet the current projected capital and operational needs for water supply and sewerage works on a self-funded basis

Actions

The City of Barrie has been involved in water conservation initiatives since 1995. At that time, the city began a fixture replacement program for residential toilets, showerheads, aerators and front-loading washing machines.

The city has adopted a number of additional programs and regulations to encourage water conservation, including:

- rain barrels
- public awareness campaigns
- a lawn watering bylaw (permitting lawn watering before 8:00 a.m. and after 6:00 p.m. and restricting it during the heat of the day)

The city also adopted an escalating rate structure to promote water conservation and preservation. It encourages users to conserve water by penalizing heavy users with higher rates. Users quickly address excessive watering of lawns and gardens and water losses due to plumbing leaks. The funding structure is self-sustaining, without reliance on tax revenues.

Implementation Details - Escalating Rate Structure

Council adopted a user-pay, self-funding business strategy in November 2001. The new rate structure has been in effect since January 1, 2002.

A switch-out program was implemented to replace meters in the community. The new meters are electronic-read meters, which are more efficient and accurate than their predecessors.

Results

There was not a substantial reduction of residential water usage in 2002; however, the city anticipates a significant decrease in 2003, as

residents are now aware of the implications of excessive water use.

The number of complaints increased by approximately 2 per cent as a result of the rate restructuring. During peak summer months, complaints doubled. It is expected that this will not occur in 2003.

Transferability

To implement an escalating water rate structure, municipalities must install residential meters and arrange for them to be read monthly.

Management

Council and Environmental Services staff review the program annually, looking at the rates and income generated by the program.

The city has contracted with a private billing contractor to monitor and read residential water metres.

Costs

The cost of implementing this initiative was minimal and included such communication activities as distributing flyers and placing a notice in the local newspaper advertising the new rate structure.

No additional costs were associated with the switch-out program for metre replacement, as the metres were due to be replaced (replacement is recommended every 15 years).

A new, web-based complaint system will help to reduce costs associated with addressing residential water service complaints.

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Case Study 12: Wastewater Treatment Using a Constructed Wetland - Town of Brighton -

Goals

- to develop a sustainable approach towards wastewater treatment
- to utilize the wetland's natural capacity to remove contaminants more cost effectively and on a longer-term basis than traditional wastewater treatment systems

Actions

The addition of a constructed wetland in September 2000 enhances the town's existing wastewater system by utilizing the same method of water treatment that works in nature.

Prior to the construction of the treatment wetland, the Brighton Water Pollution Control Plant consisted of two lagoons in series. Their wastewater treatment system was reaching capacity as the town was experiencing above-average population growth and expansion of the plant became necessary.

Implementation Details

In 1998, following the completion of a draft environmental study report, the town became interested in treatment wetlands to supplement the existing system and improve water quality. The town recognized that a wetland would allow greater capacity for the interception and removal of contaminants. This would reduce the overall loading to the adjacent Presqu'ile Bay and be more cost effective than traditional sewage treatment options.

The addition of a constructed wetland in September 2000 increased the capacity of the town's wastewater treatment system from 3,860 cubic metres per day to 4,600 cubic metres per day.

This simple, low-tech approach to wastewater treatment harnesses natural functions without the input of man-made energy. Constructed wetlands typically have few concrete and steel structures, with the majority of the area being an earthen basin.

A scoped impact assessment was completed to identify the potential impacts of the proposed constructed wetland to the nearby Presqu'ile Bay wetland, a provincially significant wetland. The minor impact on the water quality was considered acceptable by the regulators and approval was granted to proceed.

As part of the Environmental Assessment process, several open houses were held in the fall of 1998 to present the treatment wetland concept to the public. The public's concerns were addressed and the process raised public awareness of the benefits that wetlands bring to an ecosystem. In fact, children from a local school participated with the planting of the wetland by releasing more than 30 million cattail seeds over the wetland.

Construction of the wetland was completed in the fall of 1999 and it has been operating since July 2000.

The town's wastewater continues to be treated in a two-stage lagoon that reduces the concentration of contaminants. The treated wastewater is then transferred to the treatment wetland, which consists of two parallel cells with a combined area of approximately 6.2 hectares of wetted surface area. Effluent discharged from the treatment wetland is directed into the adjacent natural marsh, where contaminant loads are further reduced prior to being discharged to Presqu'ile Bay.

Results

Three years of performance data has shown that the contaminant load reduction to Presqu'ile Bay is meeting or exceeding expectations.

Additional benefits include an increase in wetland habitat and an educational and wildlife viewing opportunity.

The natural wetland treatment system requires little energy and it is not reliant on fuel burning heavy equipment for transporting outfall into Presqu'ile Bay.

Transferability

Each application of this natural treatment system technology is unique and requires a mix of engineering and innovation. A full understanding of the natural treatment system mechanisms and its challenges will ensure a smooth transition from concept to implementation.

Establishing a treatment wetland includes the challenge of obtaining approvals. While the regulators acknowledge the benefits of wetlands for contaminant reduction, they require that defensible engineering be applied in the design of these systems using current (post 1995) modelling to determine the appropriate size and configuration. Approvals for the construction of wetland technology are required under the *Ontario Water Resources Act* and given on a site-specific basis.

Children from a local school participated with the planting of the wetland by releasing more than 30 million cattail seeds over the wetland.



Constructed wetlands help to reduce the contaminant loads from discharged effluent and lower need for GHG emitting heavy equipment.

Those affected by the system, including regulators and local residents, need to be informed early in the process. Background literature and tours of existing systems help to ensure good communication. Setting aside time during a town council meeting provides an opportunity to educate council, municipal staff and the public.

Management

Limited additional training is required because the operating, monitoring and reporting regimens of a treatment wetland are similar to those of a conventional lagoon treatment system.

There are external influences, including weather conditions and wildlife, over which a wetland operator has little control. Some examples of external influences that can affect water quality are storms that cause high water levels and mammal and waterfowl that produce fecal matter. Typically, storm effects are short-lived and the system soon returns to normal. To reduce the negative effects of mammals and waterfowl, control measures (such as stone edging or 'rip rap' along berm slopes to prevent muskrat burrowing, and overhead wiring to keep waterfowl out) may need to be incorporated.

Costs

As a natural treatment option, constructed wetlands typically have lower capital, operational and maintenance costs compared to conventional treatment systems.

The total cost of the project was \$620,000, including:

- \$492,000 for construction
- \$100,000 for completion of the Environmental Assessment, engineering design, geotechnical testing and construction observation
- \$12,000 for planting materials
- \$16,000 for miscellaneous costs

Did you know?

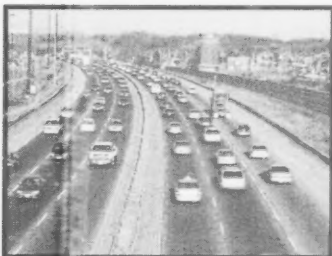
The Brighton facility is Ontario's first municipal full-scale treatment wetland technology to receive a Certificate of Approval.

Contacts

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CH2M HILL Canada Ltd
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Waterloo, ON, N2J 1P8
Tel: (519) 579-3501, ext. 228
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Case Study 13: Community Awareness Campaign - City of Hamilton -



Poor air quality, much like climate change, arises from the combustion of fossil fuels used to power cars and drive industry.

Goals

- to increase the number of businesses and organizations that are non-polluting and produce quality-of-life products and services to control, reduce and prevent pollution
- to reduce the consumption of non-renewable energy
- to reduce greenhouse gas emissions by 20 per cent from 1990 levels

Actions

In 1995, the former Region of Hamilton-Wentworth conducted an Air Quality Initiative study to identify priorities in air quality management and make recommendations related to air quality improvements.

Clean Air Hamilton was formed in 1998 to act on the findings and recommendations of the study. This committee has four working groups:

- emissions reduction
- health and environmental impacts
- research and policy development
- communication

Each group has representatives from all levels of government, local business, industry and area residents.

Within the first year, the committee initiated six programs:

- local smog response plan
- tree planting
- truck emissions modelling
- fleet greening
- street cleaning study
- public awareness campaign

Implementation Details

The public awareness campaign involved input from the working groups, the City of Hamilton and Green Venture. Green Venture is a non-profit, community-based organization that grew out of a partnership between the former Region of Hamilton-Wentworth, the Province of Ontario, utilities, private sector companies and community organizations. It is committed to promoting energy efficiency and other environmentally friendly initiatives. For more

information, visit www.greenventure.on.ca.

To date, the public awareness campaign has:

- produced smog brochures, fact sheets and posters for the city's Corporate Smog Response Plan
- developed promotional materials produced by Green Venture and the City of Hamilton's annual Commuter Challenge
- delivered verbal presentations and visual displays highlighting research results
- created a logo, website and electronic newsletter
- held annual public meetings
- hosted a bi-annual international forum for the exchange of practical solutions to air quality problems, called *Upwind Downwind: A Practical Conference on Improving Air Quality*

Future plans include finalizing a communications plan, preparing a public information kit, ongoing promotion of research and policies and incorporating all activities into a Clean Air Hamilton newsletter and video.

The committee adopted a flexible approach to create opportunities for the public and private sectors as well as community organizations to initiate action plans and projects.

Results

The principles and values of sustainable development have been firmly entrenched in the community and are a guiding force in all decisions and policy-making.

In less than five years, there has been remarkable improvement in the city's air quality. The Air Pollution Index has not reached the advisory level of 32 since June 1996 and rarely exceeds 20. Toxins in the air have been significantly reduced. For example, benzene levels decreased by more than 50 per cent.

Many successful public-private partnerships were formed and community capacity building expanded.

Transferability

An extensive public awareness campaign can be undertaken with limited resources by creating working groups, allowing smaller groups to focus on specific issues, developing partnerships and pooling resources.

Management

A member of the Corporate Communications Branch represents particular campaigns and helps prepare information on budget, finance and clean air strategies.

In less than five years, there has been remarkable improvement in the city's air quality. Toxins in the air have been significantly reduced. For example, benzene levels decreased by more than 50 per cent.

The staff report approved by council outlines the budget for the campaign and is reviewed annually.

Costs

The cost to implement a community awareness campaign can range from \$10,000 to \$200,000, depending on the scale of the initiative and the forms of communication used (e.g., mail outs, radio spots, newspaper promotional literature).

Did you know?

The city has received two international awards:

- the International Council for Local Environmental Initiatives, Local Initiative Award for air quality
- the 2000 Dubai International Award for Best Practices to Improve the Living Environment, which recognized the city's Air Quality Initiative and VISION 2020 strategy as one of the top ten strategies worldwide.

Contact

Brent Bullough
City of Hamilton Air Quality Initiative
City Hall
71 Main Street West, 5th floor
Hamilton, ON, L8P 4Y5
Tel: (905) 643-1262, ext. 275
Fax: (905) 643-7250
Email: haqic@hamilton.ca
Website: www.airquality.hamilton.on.ca

Case Study 14: Traffic Calming Plans - City of Burlington -

Goals

- to provide alternative methods to calm traffic without increasing smog and GHG emissions
- to educate residents about the negative impacts of four-way stop signs while addressing the challenge to slow traffic in neighbourhoods

Actions

Several residents and community groups asked the city to install four-way stop signs to slow traffic in their neighbourhoods. Aware that stop signs increase vehicle idling and therefore GHG emissions, the city initiated a traffic calming policy to investigate alternatives.

Annual overall gasoline consumption and fuel costs associated with traffic at stop-signs are substantial: the additional gasoline consumed from one stop sign on a typical collector road is 25 litres per day. At 65 cents per litre, the additional fuel cost is approximately \$82 per day.

In developing local Traffic Calming Plans (TCPs), the city estimates the impacts beforehand and evaluates the results afterwards. Efficient traffic control measures help to:

- reduce the total number of four-way stops
- save in overall travel time
- save in fuel consumption
- reduce vehicle emissions

Alternative measures include:

- speed bumps
- rumble strips
- visual pavement marking narrowing

The city works with its fire department to find appropriate solutions for traffic calming that also meet the needs of the fire department.

Implementation Details

Council passed a formal traffic calming policy in 1996 and distributed information about the TCPs to the public. With this policy, city staff are able to explain the policy and guide residents through

The additional gasoline consumed from one stop sign on a typical collector road is 25 litres per day.



Traffic calming zones have been used as an alternative method to calm traffic without increasing emissions.

the process of establishing a plan.

The Neighbourhood Traffic Committee (NTC) comprises council members. It makes recommendations for the project and determines the implementation costs for council. If a traffic calming measure exceeds the amount available from the capital budget for traffic calming, additional funds must be raised by the local NTC. It is the role of the NTC to encourage innovative ideas and traffic calming measures.

Results

It is estimated that the city receives over 20 requests per year for TCPs involving stop signs. Approximately half of these requests are studied by the city to determine if stop signs are an appropriate measure. Of these plans or TCPs, only half are approved by the NTC and consequently funded and implemented.



Alternative measures of traffic calming include the installation of speed bumps on residential streets.

Transferability

Traffic calming plans can be easily adopted by municipalities. Public and council support are key to successful implementation. Several municipalities already have similar programs, including Toronto,

Management

When a request is made for a four-way stop, the proposed location is evaluated by staff and presented to council. The following facts are considered:

- environmental impacts, such as increase in vehicle emissions, fuel consumption and noise generated by braking and acceleration
- disrespect for stop signs and other traffic control devices (i.e., drivers do tend to roll through the intersection or fail to stop if the sign is perceived to be unnecessary)
- inconvenience to local residents who legitimately use the roadway
- negative impact on transit routes
- security and safety for pedestrians

Costs

In 2001-2002, \$50,000 was allocated in the city's capital budget for the implementation of TCPs.

Contact

Vito Tolone
Project Leader, Transit & Traffic Department
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Fax: (905) 335-7874
Email: tolonev@burlington.ca

Did you know?

At a typical four-way stop, the following emissions are released collectively, from all vehicles travelling through a stop each year:

- 657 kg of hydrocarbons
- 8,760 kg of carbon monoxide
- 675 kg of nitrogen oxides
- 65,700 kg of carbon dioxide

Emerging Initiatives

Municipalities across the province are constantly discovering new ways to respond to the challenge of climate change. New actions increasingly in use include:

- establishing more efficient garbage pickup and street cleaning routes
- effectively disposing of hazardous wastes
- encouraging the use of bicycles for police, parking and other patrol/inspection activities
- adopting strategic energy plans
- developing energy efficiency and air quality policies in official plans
- passing anti-idling bylaws

(Federation of Canadian Municipalities, 2001)

Some specific initiatives that are underway include:

- City of Guelph: Wet-Dry Residential Recycling Program
- City of Toronto: Better Building Partnerships Program
- City of Ottawa: Strategic Energy Plan
- City of Peterborough: Green-Up Program
- City of Greater Sudbury: Land Reclamation Program
- Towns of Markham and Oakville: Traffic Calming Plans
- City of Hamilton: Fleet Conversion to Natural Gas
- City of Toronto: Solar air heating system

Has your municipality started an innovative project? The Ministry of Municipal Affairs and Housing would like to hear about your municipal actions to address the challenge of climate change. Please contact us at (416) 585-7296.

Part IV: - Opportunities for Action -

Networking for Results

Sharing innovative ideas and service delivery solutions can help minimize climate change. Organizations that support information sharing include:

- The Voluntary Challenge and Registry - a government and private-sector initiative that encourages businesses and governments to take voluntary actions to reduce GHGs. More than 750 action plans have been registered. Ontario Power Generation, Dupont Canada, Spruce Falls Inc. and Dow Chemical Canada are registered participants that have achieved significant GHG reductions through their action plans. Visit the Registry's website at www.vcr-mvr.ca/index_e.cfm.
- The Southern Ontario Clean Airshed Network Initiative (SOCANI) - a group of individuals and organizations from across southern Ontario, including citizens, politicians, municipal employees, provincial and federal employees, public health inspectors, scientists and professors. The network exchanges information on air quality developments and acts collectively on transboundary and intra-provincial air pollution issues. Visit the network's website at <http://socani-network.tripod.com/>.
- The Federation of Canadian Municipalities - a group that concentrates on municipal achievements and opportunities. Municipalities that are members of the federation's Partner for Climate Protection Program exchange information relating to emission reduction programs. For more information, visit the federation's website at www.fcm.ca.
- The Greater Toronto Area Clean Air Council - an inter-governmental working group dedicated to exploring joint clean air initiatives and to liaising with municipalities across Canada to discover best practices for reducing smog. For details, visit the City of Toronto's website at www.city.toronto.on.ca/gtacac.
- The Clean Air Foundation - a not-for-profit organization dedicated to developing, facilitating and implementing public engagement programs and strategic initiatives that lead to a measurable improvement in air quality. The foundation brings

**See Case Study 5 for
the City of Windsor's
Energy Performance
Contracting initiative.**

together experts and resources from government, business and relevant public interest organizations. For more information, visit the foundation's website at www.cleanairfoundation.org.

Partnerships for Results

Several projects featured in this handbook were a combination of private or public-private ventures. Partnerships offer municipalities the potential to reduce costs, add resources and access the expertise of external partners. For example, energy services companies enter into partnership contracts with municipalities to provide services related to municipal energy needs.

Did you Know?

The Canadian Council For Public-Private Partnerships website offers information on public-private partnerships www.pppcouncil.ca.

Resources and Funding

Several funding programs are available to municipalities to support local climate change actions. Here are some potential sources:

- The federal government sponsors the Climate Change Action Fund. It supports actions to reduce GHG emissions and increase understanding and awareness of climate change. Visit the fund's website at www.climatechange.gc.ca/english/ccaf.
- The Federation of Canadian Municipalities administers the Green Municipal Funds Program. The program provides funding and support to municipalities that implement innovative environmental projects, particularly those that reduce GHG emissions. There are two funds in the program: the Green Municipal Investment Fund, a permanent \$200 million revolving fund that provides low-interest loans to municipalities and the Green Municipal Enabling Fund, a \$50 million fund that provides grants to municipalities to support feasibility studies. Visit the federation's website at www.fcm.ca for details.
- Individual organizations with an interest in improving energy efficiency and reducing GHG emissions often provide loans or grants to municipalities. For example, Ottawa's street lighting conversion was paid for, in part, through grants from the former Ontario Hydro. Natural Resources Canada, through their CANMET program, paid for the feasibility study of Cornwall's Cogeneration District Heating System.
- Some municipalities have initiated their own funds to support air quality initiatives. The City of Toronto's Atmospheric Fund was established through a windfall capital gain resulting from the sale of a large parcel of land; the city also obtained special legislation for this initiative. City council agreed to use the \$23 million towards a capital revolving fund to help the city meet its objective to reduce GHG emissions. Loans and grants are made available to community groups, government organizations and businesses that work in partnership with the city to reduce emissions.

Other Resources and Contacts

Municipal Programs and Education Branch

777 Bay Street, 3rd floor
Toronto, ON, M5G 2E5
(416) 585-7296 Fax: (416) 585-7292

Municipal Services Offices:

Central, Toronto
777 Bay Street, 2nd Floor
Toronto, ON, M5G 2E5
(416) 585-6226
Toll Free: 1-800-668-0230 Fax: (416) 585-6882

Northwestern, Thunder Bay
435 St. James St. S, Suite 223
Thunder Bay, ON, P7E 6S7
(807) 475-1651
Toll Free: 1-800-465-5027 Fax: (807) 475-1196

Northeastern, Sudbury
159 Cedar Street, Suite 401
Sudbury, ON, P3E 6A5
(705) 564-0120
Toll Free: 1-800-461-1193 Fax: (705) 564-6863

Eastern, Kingston
Rockwood House
8 Estate Lane
Kingston, ON, K7M 9A8
(613) 548-4304
Toll Free: 1-800-267-9438 Fax: (613) 548-6822

Southwestern, London
659 Exeter Road, 2nd Floor
London, ON, N6E 1L3
(519) 873-4020
Toll Free: 1-800-265-4736 Fax: (519) 873-4018

Ministry of Municipal Affairs and Housing: <http://www.mah.gov.on.ca/>

Ministry of the Environment: <http://www.ene.gov.on.ca/>

Ministry of Public Infrastructure Renewal's Smart Growth website:
<http://www.smartgrowth.gov.on.ca/>

Selected Internet Resources

The following documents about air quality and climate change in Ontario are available electronically through the Ministry of the Environment's website and other sources. *Note: this is a partial list only.*

2001 Air Quality Report

<http://www.ene.gov.on.ca/envision/air/AirQuality/2001.htm>

Air Quality and Climate Change: Moving Forward [http://](http://www.ene.gov.on.ca/envision/air/airclimate/airclimate.htm)

www.ene.gov.on.ca/envision/air/airclimate/airclimate.htm

Climate Change and Global Warming

<http://www.ene.gov.on.ca/cons/3560e.pdf>

Climate Change and Health Office (Health Canada)

<http://www.hc-sc.gc.ca/hecs-sesc/ccho/>

Compendium of Current Knowledge of Fine Particulate Matters in Ontario

http://www.ene.gov.on.ca/envision/env_reg/er/documents/pa9e0008/list.htm

Green Roofs for Healthy Cities

<http://www.greenroofs.org>

Institute for Research in Construction

<http://irc.nrc-cnrc.gc.ca/>

Local Enhancement and Appreciation of Forests

<http://leaftoronto.org>

Ontario's Smog Plan

<http://www.ene.gov.on.ca/programs/3573e.pdf>

Setting Air Quality Standards in Ontario

<http://www.ene.gov.on.ca/envision/air/airquality/standards.htm>

Smog Alert: A Municipal Response Guide

<http://www.ene.gov.on.ca/envision/gp/3760e.pdf>

Tools of Change: Proven Methods for Promoting Health and
Environmental Citizenship

<http://www.toolsofchange.com/>

Other information can be obtained from the National Research
Council.

References

The following documents were cited in this Handbook:

Environment Canada. (1998) *Urban Water: Municipal Water Use and Wastewater Treatment*. State of the Environment Bulletin, No. 984.

Federation of Canadian Municipalities. (2001) *A Plan to Achieve 20 per cent of the Kyoto Target*.

Green Roofs for Healthy Cities website <http://www.greenroofs.org>

Intergovernmental Panel on Climate Change (IPPC). (2001) *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881 pp.

Local Enhancement and Appreciation of Forests website <http://leaftoronto.org>

Ministry of the Environment. (2001). *Air Quality and Climate Change: Moving Forward*. Toronto: Queen's Printer for Ontario. <http://www.ene.gov.on.ca/envision/air/airclimate/airclimate.htm>.

Pembina Institute. *Climate Change Solutions* website www.climatechangesolutions.com.

Public Works and Government Services Canada. (2002). *Sustainable Development Performance Report 2001/2002*.

Tools of Change: Proven Methods for Promoting Health and Environmental Citizenship website – <http://www.toolsofchange.com/English/CaseStudies/default.asp?ID=105>

Glossary:

Biogas – Gas collected from the decomposition of organic materials in sewage sludge.

CO – Carbon Monoxide, a hazardous air pollutant.

CO₂ – Carbon Dioxide, a significant greenhouse gas and a product of fossil-fuel combustion.

Cogeneration is the simultaneous production of heat energy and electrical or mechanical power from the same fuel. For example, where steam is produced to generate electrical power, the heat that might otherwise be wasted is captured for space heating.

Fine particulate matter consists of either solid particles or fine liquid droplets including aerosols, smoke, fumes, dust, fly ash and pollen. The composition varies with place and season. Particles in the atmosphere are classified by size, mainly because of the different health effects from particles of different diameters. The smaller the particle size, the further the particle will penetrate into the lungs.

Greenhouse gases (GHGs) are gases, such as water vapour and carbon dioxide, that absorb and re-radiate infrared energy. A certain level of GHGs in the atmosphere is essential to maintain the earth's temperature at a level that can support life. However, as the concentration of GHGs in the atmosphere increases, more heat is trapped and the overall global temperature rises. The most significant GHG contributors are carbon dioxide, methane, nitrous oxide, ozone, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

Hazardous air pollutants are potentially toxic substances present in our atmosphere that can have harmful effects on our environment and our health. Vehicles are significant sources, including fine particulate matter, benzene and polycyclic aromatic hydrocarbons. Hazardous air pollutants can cause serious health problems; some are considered carcinogenic. Each year, millions of tonnes of toxins are released into the air across North America, mostly from human activities.

N₂O – Nitrous oxide is a greenhouse gas that is emitted by agricultural soils which use nitrogen fertilizers and the consumption of fossil fuels.

NO_x – Nitrogen oxides is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. The major sources of NO_x are motor vehicles, electric utilities and other industrial, commercial and residential sources that burn fossil fuels. Other sources include biomass burning and soil emissions.

O₃ or Ozone is the triatomic form of oxygen and is a gaseous atmospheric constituent. Ozone is created both naturally and by photochemical reactions involving gases resulting from human activities. A key ingredient in smog, ozone is harmful to a wide range of living organisms. Ground-level ozone is formed when nitrogen oxides and volatile organic compounds react together in strong sunlight and is the main active and harmful ingredient in smog. The same ozone at elevations between 18 and 35 kilometres above the earth's surface effectively absorbs 97-99 per cent of ultraviolet radiation from the sun.

Smog is the most visible form of air pollution and is of particular concern in several of Canada's major urban areas. It is often visible as a brown, grey, or white fog over urban areas. Ground-level ozone, the major component of smog, is formed when nitrogen oxides and volatile organic compounds react in the presence of warm temperatures and sunlight. Another key element of smog is fine particulate matter. The major urban source of these smog pollutants is the burning of fossil fuels in vehicles, factories, thermal power plants and home furnaces. Volatile organic compounds are also found in solvents, oil-based paints and gasoline.

Urban heat island effect describes a city environment with higher average temperatures than its surroundings because of human alteration of the landscape. It is primarily caused by inadvertent climate modification as more buildings, asphalt and urban development have supplanted vegetation and trees and as human activity generates heat. The effect is felt most in the summer when temperatures are already high. Not all cities experience the Urban Heat Island effect; its occurrence depends on several factors, including regional weather patterns, topography and the density of streets, buildings and gardens.

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